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Abstract

PHASE EQUILIBRIA BETWEEN INTERMETALLIC COMPOUNDS IN URANIUM ALLOYS

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Intermetallic uranium compounds are of great practical importance:

1. As constituents in most uranium alloys.
2. As fissionable substances dispersed in metals of suitable nuclear properties.
3. As reaction products between uranium-containing fuels and can materials.
4. As potential fuel materials.

In all cases the intermetallic compounds influence the properties of uranium alloys, cans, and matrix materials of dispersion-type fuel elements. Therefore, the practical use of uranium-containing alloys required a good knowledge of constitution, properties, phase relations, and stabilities of intermetallic uranium compounds. Careful constitutional investigations combined with corresponding measurements of the most interesting properties are normally the first step in establishing the desired knowledge. To this a contribution is given in the present paper.

More than thirty phase diagrams of multicomponent uranium alloy systems have been studied by us. Thereby relatively often quasibinary, quasiternary etc. phase relations, and some ternary uranium compounds have been found.

Under consideration of all known data in this field, the quasibinary systems can be divided into three types:

Type I: Systems between intermetallic uranium compounds.

Type II: Systems between one intermetallic uranium compound and one of the pure components.

Type III: Systems between one intermetallic uranium compound and one intermetallic uranium-free compound.

All these quasibinaries are simple eutectic systems if the boundary compounds exhibit different crystal structures (for example: U_3Si_2-UAl_2, Mo-UAl_2 $ZrAl_2$-UAl_2, UIr_2-URe_2 etc.). Generally, the two-phase regions in these eutectic systems extend over a wide range of concentration and temperature.

In quasibinary systems having boundary compounds with the same crystal structure complete solid solubility (for example: UFe_2-UIn_2, UFe_2-UOs_2, UCo_2-UIr_2 etc.) or ternary uranium compounds (for example: UFe_2-UNi_5, UAl_2-UNi_5, UAl_2-UFe_2 etc.) have been observed. So far 12 new ternary compounds have been found and determined.

It is possible to give a systematic arrangement of the experimental results in terms of valency electron concentration which in turn allows some predictions of the constitution of the quasibinaries and the nature of the ternary phases. Furthermore, on this basis the identification of unknown intermetallic uranium phases in technical alloys is possible.

Preparation, workability, casting properties, melting points, thermal expansion, corrosion and transformation behaviour, and other properties of some quasibinary uranium alloys and ternary compounds have been examined. It has been found that some of these alloys exhibit remarkable properties which make them attractive as potential fuel materials.